CETA 82-6

A Low-Cost Planting Technique for Eelgrass (*Zostera marina* L.)

by

Mark S. Fonseca, W. Judson Kenworthy, and Gordon W. Thayer

COASTAL ENGINEERING TECHNICAL AID NO. 82-6

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Prepared for

U.S. ARMY, CORPS OF ENGINEERS

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REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER CETA 82-6	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) A LOW-COST PLANTING TECHNIQUE FOR EELGRASS (ZOSTERA MARINA L.)		5. TYPE OF REPORT & PERIOD COVERED Coastal Engineering Technical Aid
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Mark S. Fonseca W. Judson Kenworthy Gordon W. Thayer		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS National Marine Fisheries Service Southeast Fisheries Center, Beaufort Laboratory Beaufort, NC 28516		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS G31632
11. CONTROLLING OFFICE NAME AND ADDRESS Department of the Army (CERRE-CE) Coastal Engineering Research Center Kingman Building, Fort Belvoir, VA 22060		12. REPORT DATE December 1982
		13. NUMBER OF PAGES 15
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Cost evaluation
Current regime
Seagrass
Sediment stabilization
Transplanting techniques

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Transplanting of eelgrass (Zostera marina) has undergone considerable experimental study in the last decade, but with limited practical application. A new technique has been developed using bundles of mature, vegetative shoots of eelgrass washed free of sediment and anchored in the bottom. Using this technique, planting units have been successfully established in high (>1.6 feet per second) and low (<1.6 feet per second) current regimes on grids of 2.0 and 2.6 feet, respectively. The production-line efficiency of the technique greatly reduces planting costs. Methods developed for selecting wild planting stock and anchoring planting units greatly increases planting success across the range of current velocities in which eelgrass is found.

PREFACE

This report is published to provide coastal engineers with a low-cost eelgrass transplanting technique which is suitable for establishment in both high current and quiescent marine habitats. It is intended to update information on planting techniques presented in "Planting Guidelines for Seagrasses," (Phillips, 1980).

The work was carried out under the U.S. Army Coastal Engineering Research Center's (CERC) Coastal Engineering Uses of Submerged Plants work unit, Environmental Impact Program, Environmental Quality Area of Civil Works Research and Development.

The report was prepared by Mark S. Fonseca, Department of Environmental Sciences, University of Virginia, in affiliation with the National Marine Fisheries Service, Southeast Fisheries Center, Beaufort Laboratory, Beaufort, North Carolina, and W. Judson Kenworthy and Gordon W. Thayer of the Beaufort Laboratory.

The authors express appreciation to M. LaCroix and T. Currin for assistance in field exercises, and to H. Gordy for graphics.

Paul L. Knutson was technical monitor for this report, under the general supervision of E.J. Pullen, Chief, Coastal Ecology Branch and Mr. R.P. Savage, Chief, Research Division, CERC.

Technical Director of CERC was Dr. Robert W. Whalin, P.E., upon publication of this report.

Comments on this publication are invited.

Approved for publication in accordance with Public Law 166, 79th Congress, approved 31 July 1945, as supplemented by Public Law 172, 88th Congress, approved 7 November 1963.

Ted E. Bishop

TED E. BISHOP
Colonel, Corps of Engineers
Commander and Director

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CONVERSION FACTORS, U.S. CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT

U.S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	by	To obtain
inches	25.4	millimeters
	2.54	centimeters
square inches	6.452	square centimeters
cubic inches	16.39	cubic centimeters
feet	30.48	centimeters
	0.3048	meters
square feet	0.0929	square meters
cubic feet	0.0283	cubic meters
yards	0.9144	meters
square yards	0.836	square meters
cubic yards	0.7646	cubic meters
miles	1.6093	kilometers
square miles	259.0	hectares
knots	1.852	kilometers per hour
acres	0.4047	hectares
foot-pounds	1.3558	newton meters
millibars	1.0197×10^{-3}	kilograms per square centimeter
ounces	28.35	grams
pounds	453.6	grams
	0.4536	kilograms
ton, long	1.0160	metric tons
ton, short	0.9072	metric tons
degrees (angle)	0.01745	radians
Fahrenheit degrees	5/9	Celsius degrees or Kelvins[1]

[1]To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use formula: $C = (5/9)(F - 32)$.

To obtain Kelvin (K) readings, use formula: $K = (5/9)(F - 32) + 273.15$.

A LOW-COST PLANTING TECHNIQUE FOR EELGRASS (Zostera marina L.)

by

Mark S. Fonseca, W. Judson Kenworthy, and Gordon W. Thayer

I. INTRODUCTION

Cooperative research by the Beaufort Laboratory of the Southeast Fisheries Center, National Marine Fisheries Service, and the U.S. Army Coastal Engineering Research Center (CERC) has developed a low-cost transplanting technique for eelgrass (Zostera marina L.). This technique can be used for planting and rehabilitating areas damaged by coastal engineering activities, for creating eelgrass beds to stabilize substrates, and provide habitats for numerous commercially and recreationally important marine species. The planting technique may also prove to be effective for other seagrass species.

II. HARVESTING AND STORING PLANTS

1. Identifying Preferred Harvest Sites.

Research has demonstrated that eelgrass transplants obtained from high current areas have superior growth rates (Fonseca, et al., 1979) and higher rhizome mat integrity which improves collection efficiency (Fonseca, Kenworthy, and Thayer, 1981). High current areas are defined as those areas where the surface current velocity often exceeds 1.6 feet (50 centimeters) per second. These areas are characterized by discrete, raised patches of grass on a sandy substrate of low organic matter (Fig. 1) (Kenworthy, 1981).

2. Harvest Technique.

Harvesting entails digging up sods of eelgrass with a shovel that is inserted at least 8 inches (20 centimeters) into the substrate so as to include the whole root-rhizome complex. These sods should be shaken free of any attached sediment at the harvest site. Care should be taken to maintain the carpetlike integrity of the rhizomes to facilitate later planting.

3. Storage Guidelines.

Sediment-free mats of seagrass should be stored in ambient seawater and processed into planting units within 36 hours. Aeration of the storage containers (plastic trash cans work well) is often required to prevent anaerobic conditions. Setting the mats into shallow, flowing seawater tables works best and provides an ideal working area for preparing the planting units.

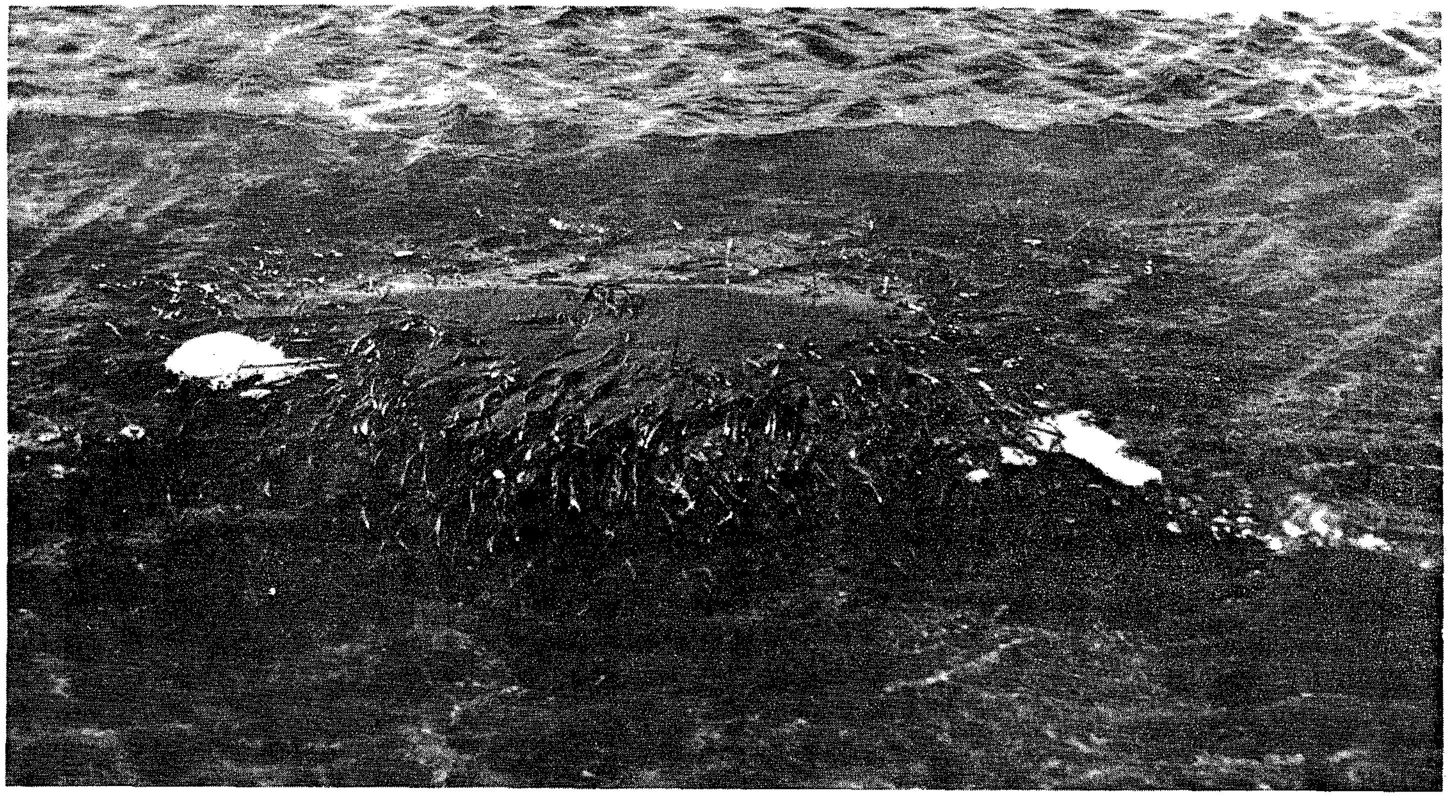

Figure 1. A photo of a high current area eelgrass meadow at low tide. Note the isolated and mounded nature of the meadow. The scale of the vegetated area is 1 meter.

III. PREPARING PLANTING UNITS

Past plantings have used either whole plugs of sediment from natural seagrass beds or, in a few cases, shoots that have been washed free of sediment. Plugs create excessive logistical problems due to their weight and size. Shoots without sediment circumvent this problem, but anchoring techniques have previously proven successful only in low energy environments.

Figures 2 to 5 illustrate the four-step procedure for preparing planting units:

(1) The eelgrass is dug up and washed free of sediment at the harvest site, taking care to keep the root-rhizome system intact (Fig. 2).

(2) Shoots are pulled in clumps from the dug-up mats and held upright to make the planting units (approximately 15 shoots per planting unit) (Fig. 3).

(3) One-third (about 8 inches) of a metal coathanger (pre-cut and bent to form an L-shape for anchoring purposes) is added to the shoots, which are then wrapped with a piece of bonded construction paper (filecards cut in strips also work well) and secured with a twist-tie fastener, forming the finished planting unit (Fig. 4).

(4) The plants are transported to a planting site in small containers that are filled with water (Fig. 5). The quantity of plants in the containers shown in Figure 5 will plant more than 250 square yards (200 square meters).

IV. PLANTING METHOD

The proper planting of the eelgrass unit is critical for its survival. Inserting the plants into the sediment so that the top of the L-shaped anchor is covered with sediment is a stringent requirement. Plantings should be made on 2.6-foot (0.79 meter) centers for the low current areas (surface current velocity not exceeding 1.6 feet per second) and 2-foot (0.61 meter) centers for the high current areas. Since the eelgrass tends to propagate in the direction of the least resistance, the down-current spacing in the high current areas should be shortened to 1.8-foot (0.55 meter) centers, while the cross-current spacing should be lengthened to 2.2 foot (0.66 meter) centers.

The planting units are easily inserted, even into compacted sand, by the creation of a lead hole (a heavy dive knife works well). Planting time is actually faster when using scuba divers rather than wading workers if leadlines with interval markings are used as planting guides. Planting should always be done while facing into the current flow.

V. PLANT MATERIAL REQUIREMENTS

1. <u>Number of Units Required for a Planting</u>.

Number of planting units =

$$\text{planting area (square feet)} \times \frac{1}{(\text{plant spacing})^2} \tag{1}$$

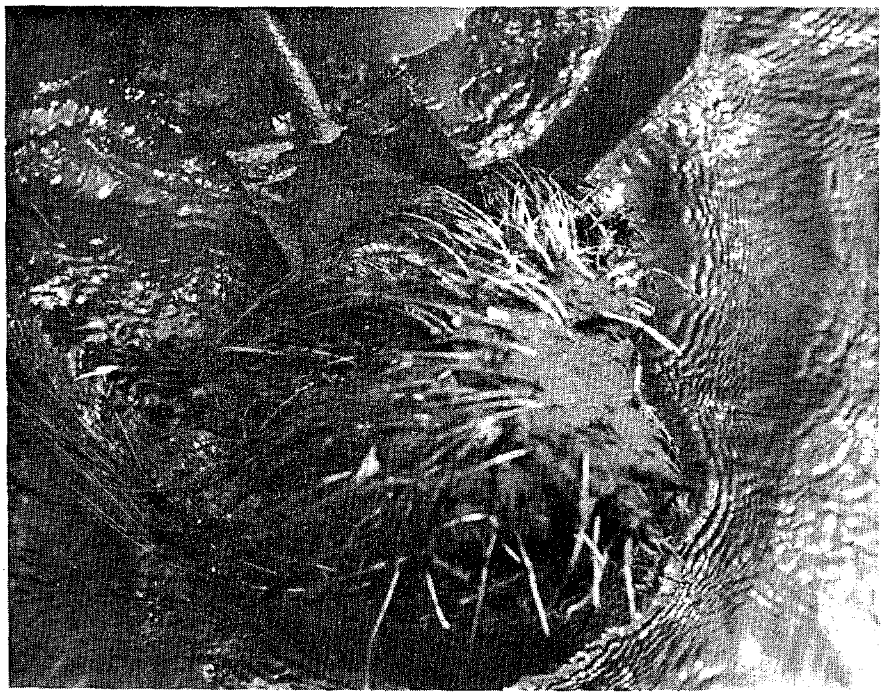

Figure 2. Plant collection.

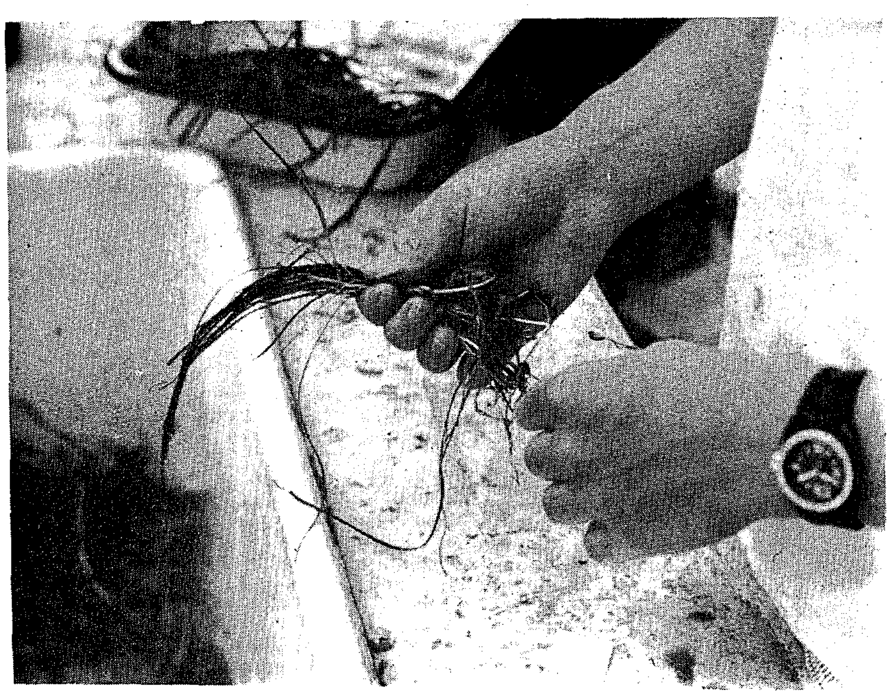

Figure 3. Isolating the proper number of shoots per planting unit.

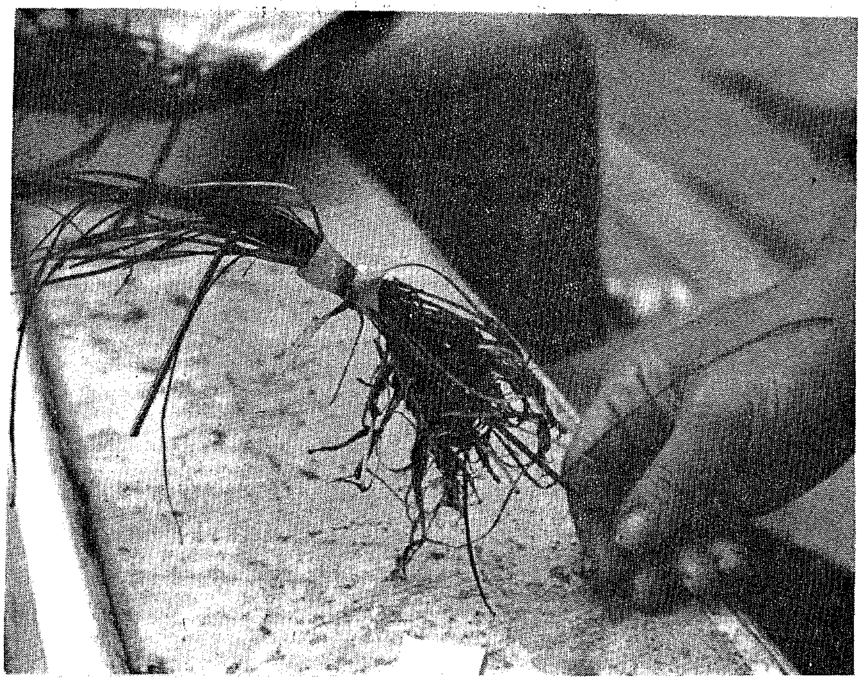

Figure 4. Attachment of anchor and fasteners; one planting unit.

Figure 5. Placing the planting units into containers for transport to the planting site.

plant spacing = 2.6-foot grid in low current areas,

2.2-foot by 1.8-foot (average spacing of 2.0-feet)

grid in high current areas.

Therefore, planting in low current areas will require about 6,440 planting units per acre (15,910 planting units per hectare) while plantings in high current areas will require about 10,890 units per acre (26,910 units per hectare), to obtain completed cover in one growing season.

2. Number of Shoots Required for a Planting.

$$\text{Number of planting units} \times \frac{\text{number of shoots}}{\text{planting unit}} = \text{number of shoots harvested,} \qquad (2)$$

:number of shoots per planting unit = 15 mature, vegetative shoots.

Therefore, shoots required for 1 acre of planting in a low current area are about 96,600 and about 163,350 for a high current area.

VI. LABOR REQUIREMENTS

1. Harvesting.

a. The harvest rate is about 18,000 shoots per man-hour.

b. Approximately 5 man-hours are required to harvest the 96,600 shoots necessary for a 1-acre planting in a low current area.

c. Approximately 9 man-hours are needed to harvest the 163,350 shoots required for a 1-acre planting in a high current area.

2. Preparation of Planting Units.

a. The fabrication rate of the planting units is approximately 100 per man-hour.

b. Approximately 64 man-hours are required to fabricate the 6,440 planting units necessary for 1 acre of low current planting.

c. Approximately 109 man-hours are required for the fabrication of the 10,890 planting units for 1 acre of high current planting.

3. Planting.

a. The planting rate is about 150 planting units per man-hour for most habitats. Planting can be conducted by wading in water depths up to about 2 feet (0.6 meter). Planting in deeper areas may require scuba gear.

b. Scuba-assisted workers can plant at least 15 percent faster than the wading, nonscuba assisted workers, but the wage difference has always resulted in nonscuba workers being the most economical when conditions permit.

c. Approximately 43 man-hours are required to plant the 6,440 planting units for a 1-acre, low current planting.

d. Approximately 73 man-hours are required for planting the 10,890 planting units for a 1-acre, high current area.

4. Total Operation.

a. Labor per acre of low current area:

Harvest	5 man-hours
Preparation	64 man-hours
Planting	43 man-hours
Total	112 man-hours

b. Labor per acre of high current area:

Harvest	9 man-hours
Preparation	109 man-hours
Planting	73 man-hours
Total	191 man-hours

With the improved seagrass planting technique presented in this report, seagrass meadows can be established with a labor effort of 100 to 200 man-hours per acre (250 to 500 man-hours per hectare).

VII. SUMMARY

Labor estimates for transplanting eelgrass have been reported as high as 4,081 man-hours per acre (10,084 man-hours per hectare) for plugs and as low as 189 man-hours per acre (467 man-hours per hectare) for unanchored shoots (see Table). The improved planting units described in this report are as stable as plugs and are as labor-saving as unanchored shoots. They have proven to be effective in a wide range of current and wave regimes.

The labor estimates included in this report and in most literature on this subject reflect only the effort required to perform specific planting operations. The additional costs that are associated with actual projects such as mobilization, planning and administration, transportation of materials, travel, equipment, downtime, overhead, and profit are not considered in these estimates. Because of this, contract costs are generally much higher than reported labor estimates imply. Contract costs for the improved planting technique presented here will range from $10,000 to $15,000 per acre

Table. Labor estimates (by source).

Source	Technique	Man-hours per acre
Fonseca, et al., 1979	Fifteen shoots in bio-degradable mesh.	262
Churchill, Cok, and Riner, 1978	Unanchored shoots.	189
Robilliard and Porter, 1976 (estimated from manuscript)	Plugs of whole shoots with attached sediment.	4,081

($30,000 to $45,000 per hectare) in 1982 dollars for most projects. This low-cost technique provides substantial savings in labor, transportation of materials, and purchase of equipment.

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